SOME DISSIPATIVE FLOWS OF SOAP FILMS AND FOAMS

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In this seminar, I will present two of our current research topics: the motion of soap films in tubes, and the response of a foam to air injection. The two subjects are strongly related to viscous dissipation in thin films, in relation with surfactant dynamics.

We devised a simple experiment in which a single soap film is pushed at constant velocity through a tube. In the case of SDS soap films, expected to be in the mobile regime, we show how viscous friction in the transition zones between the Plateau borders and the wetting film controls the departure from the equilibrium shapes. We propose a simple theoretical criterion for the highest possible velocity of a soap film through a tube, for different tube geometries, in excellent agreement with our measurements [Dollet & Cantat 2010]. As a model system for immobile interfaces, SLES/CAPB/MAc [Golemanov et al. 2008] displays a wealth of behaviors very distinct from SDS. We show that the moving soap film influences the wetting film at long distances in front of him. The thickness profile of the wetting film varies continuously along this "influence" zone. The soap film can show an intermittent regime, strikingly reminiscent of stick-slip. We attempt to rationalize these observations, by coupling hydrodynamics in the films and surfactant properties.

The response of a two-dimensional liquid foam to a localised air injection is investigated experimentally and theoretically. The experiments show a rich phenomenology (figure 1). At low flux, the injected air forms a central bubbles that grows inside the foam and induces plastic rearrangements, without film rupture. This "pure swelling" regime is reminiscent of ductile fracture. In this regime, the central bubble shows fingering patterns beyond a certain velocity. The dependences between the swelling rate, the injection overpressure and the other control parameters: cell gap, bubble size and foam area, is captured by a simple balance between the pressure drop and bubble/wall friction, within a radial assumption. Fingering is successfully modelled by the linear stability analysis of an azimuthal perturbation of the radial model; yield stress becomes an important parameter to determine the finger width. At high injection rate, films are broken and narrow cracks form rapidly through the foam, which reminds brittle fracture. Criteria on the transition between ductile and brittle behaviours are investigated, both at the local and global scales.

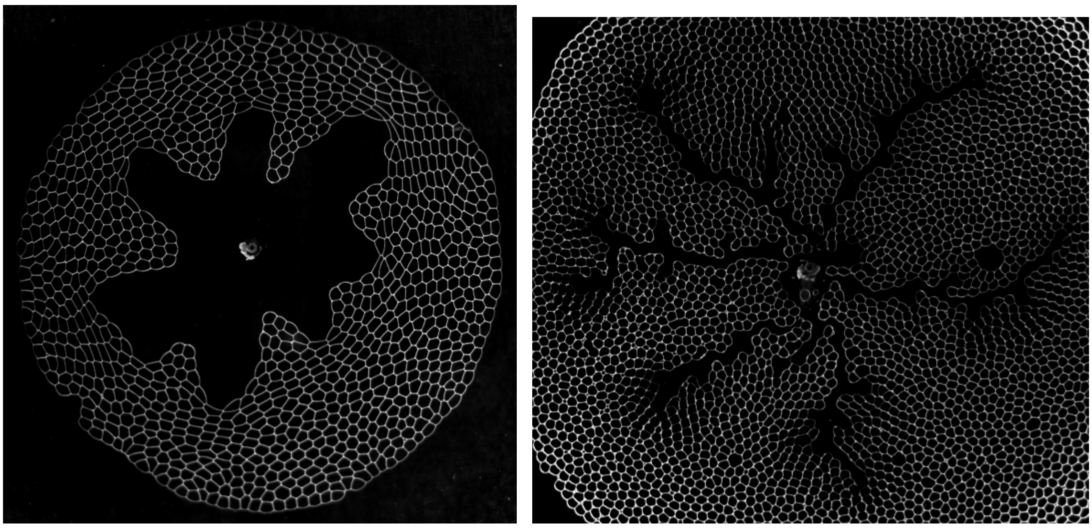

Figure 1: Snapshots of 2D foams in which air is injected. Left: at low injection flux, a central bubble grows and shows fingering. Right: at high flux, brittle cracks are formed within the foam.